

AMENDMENTS TO THE CLAIMS:

This listing of claims will replace all prior versions and listings of claims in the application:

1. (Currently amended) An apparatus for decoding a Reed-Muller code in which information data is encoded by using mask symbols and orthogonal codes, the information data including a first portion and a second portion, the apparatus comprising:

an arithmetic operation unit configured to calculate a first an exclusive OR of [[the]] a first Reed-Muller code and each of a plurality of mask patterns to obtain a first exclusive OR output, each of the mask patterns representing an exclusive ORed value of a candidate pattern of the mask symbols and the first portion of the information data corresponding to the candidate pattern;

a first decoder configured to calculate to decode a part of the second portion of the information data that corresponds to the orthogonal codes by calculating a checksum of the first exclusive OR output to obtain a plurality of checksum outputs and majority-decide deciding by majority a value of each of the checksum outputs to decode a part of the second portion of the information data corresponding to the orthogonal codes;

a second decoder configured to calculate to decode a remaining part of the second portion of the information data by calculating a second exclusive OR of the first exclusive OR output and a product of the part of the second portion of the information data and the orthogonal codes to obtain a second exclusive OR output, and majority-

decide deciding by majority a value of the second exclusive OR output to decode a remaining part of the second portion of the information data corresponding to the orthogonal codes;

a Reed-Muller encoder configured to Reed-Muller encode the decoded second portion of the information data output from the first decoder and the second decoder and the first portion of the information data into a plurality of second Reed-Muller codes corresponding to the mask patterns, the decoded second portion including the decoded part and the decoded remaining part output from the first decoder and the second decoder;

a Euclidean distance calculator to calculate a Euclidean distance between the first Reed-Muller code and each of the second Reed-Muller codes to obtain a plurality of Euclidean distances; and

a minimum distance detector configured to detect [[the]] a minimum Euclidean distance of a among the Euclidean distances to decode the information data using one of the mask patterns that corresponds to the minimum Euclidean distance, between an output from the Reed-Muller encoder and the Reed-Muller code supplied to the arithmetic operation unit while a plurality of candidate patterns of the mask symbols are supplied to the arithmetic operation unit,

whereby the first portion of the information data is decoded based on the mask symbols corresponding to the minimum of the Euclidean distance.

2. (Currently amended) The apparatus according to claim 1, further comprising a memory configured to store a plurality of exclusive ORed values of a plurality of

~~candidate patterns of the mask symbols and a plurality of information data corresponding to the candidate patterns corresponding to the mask patterns, and wherein the arithmetic operation unit calculates the first exclusive OR of the first Reed-Muller code[[s]] and each of the plurality of exclusive ORed values stored in the memory.~~

3. (Currently amended) The apparatus according to claim 1, further comprising a hard decision unit ~~configured~~ to hard-decide the first Reed-Muller code supplied to the arithmetic operation unit.

4. (Currently amended) The apparatus according to claim 1, wherein the first decoder comprises:

a memory ~~configured~~ to store the first exclusive OR output from the arithmetic operation unit;

a checksum calculator ~~configured~~ to read bit data from the memory and calculate a plurality of exclusive ORs of a plurality of sets of the read bit data to obtain a plurality of the checksum[[s]] outputs;

a selector ~~configured~~ to select some of the plurality of checksum[[s]] outputs based on a type of the Reed-Muller code;

an accumulator ~~configured~~ to accumulate the selected checksums; and

a hard decision unit ~~configured~~ to hard-decide an output from the accumulator.

5. (Currently amended) A method of decoding a Reed-Muller code in which information data is encoded by using mask symbols and orthogonal codes, the information data including a first portion and a second portion, the method comprising:

calculating a first an exclusive OR of [[the]] a first Reed-Muller code and each of a plurality of mask patterns to obtain a first exclusive OR output, each of the mask patterns representing an exclusive ORed value of a ~~candidate pattern~~ of the mask symbols and the first portion of the information data ~~corresponding to the candidate pattern~~;

calculating a checksum of the first exclusive OR output to obtain a plurality of checksum outputs; [[and]]

~~majority judging~~ deciding by majority a value of each of the checksum outputs to decode a part of the second portion of the information data corresponding to the orthogonal codes;

calculating a second exclusive OR of the first exclusive OR output and a product of the part of the second portion of the information data and the orthogonal codes to obtain a second exclusive OR output; [[and]]

~~majority judging~~ deciding by majority a value of the second exclusive OR output to decode a remaining part of the second portion of the information data ~~corresponding to the orthogonal codes;~~

~~Reed-Muller~~ encoding the decoded second portion of the information data and the first portion of the information data into a second Reed-Muller code, the decoded second portion including the decoded part and the decoded remaining part; [[and]]

calculating a Euclidean distance between the first Reed-Muller code and each of the second Reed-Muller codes to obtain a plurality of Euclidean distances; and
detecting [[the]] a minimum of a Euclidean distance between the Reed-Muller encoded data and an input Reed-Muller code while a plurality of first exclusive ORs are calculated, whereby the first portion of the information data is decoded based on the mask symbols corresponding to the minimum of the Euclidean distance among Euclidean distances to decode the information data using one of the mask patterns that corresponds to the minimum Euclidean distance.

6. (Currently amended) An apparatus for decoding Reed-Muller code in which information data is encoded by using mask symbols and orthogonal codes, the information data including a first portion and a second portion, the apparatus comprising:

a first arithmetic operation unit configured to calculate an exclusive OR of the Reed-Muller code and each of a plurality of mask patterns to obtain an exclusive OR output, each of the mask patterns representing an exclusive ORed value of a candidate pattern of the mask symbols and the first portion of the information data corresponding to the candidate pattern;

a decoder configured to decode the second portion of the information data which corresponds to the orthogonal codes calculate by calculating a checksum of the exclusive OR output to obtain a plurality of checksum outputs and majority decide deciding by majority a value of each of the checksum outputs to decode a part of the second portion of the information data corresponding to the orthogonal codes;

a second arithmetic operation unit ~~configured~~ to calculate a first accumulation result of ~~each~~ bit bits of a product of an output from the decoder and the orthogonal codes and a second accumulation result of [[each]] inverted bits of a product of the output from the decoder and the orthogonal codes and detect one of the first accumulation result and the second accumulation result which corresponds to a smaller Euclidean distance between the Reed-Muller code input to the first arithmetic operation unit and encoded data of decoded data of the decoder;

a minimum detector ~~configured~~ to detect the minimum of an output from the second arithmetic operation unit while ~~a plurality of candidate patterns of the mask symbols~~ the mask patterns are supplied to the first arithmetic operation unit[[,]]; and whereby a decoder to decode the first portion of the information data ~~is decoded~~ based on the mask symbols pattern corresponding to the minimum of the output from the second arithmetic operation unit.

7. (Currently amended) The apparatus according to claim 6, further comprising a memory ~~configured~~ to store a plurality of exclusive ORed values of a plurality of candidate patterns of the mask symbols the mask patterns and a plurality of the information data corresponding to the candidate mask patterns, and wherein the first arithmetic operation unit calculates the exclusive OR of the Reed-Muller code[[s]] and each of the plurality of exclusive ORed values stored in the memory.

8. (Currently Amended) The apparatus according to claim 6, further comprising a hard decision unit ~~configured~~ to hard-decide the Reed-Muller code supplied to the first arithmetic operation unit.

9. (Currently amended) The apparatus according to claim 6, wherein the decoder comprises:

a memory ~~configured~~ to store the exclusive OR output from the first arithmetic operation unit;

a checksum calculator ~~configured~~ to read bit data from the memory and calculate a plurality of exclusive ORs of a plurality of sets of the read bit data to obtain ~~a plurality of checksums~~ the checksum outputs;

a selector ~~configured~~ to select some of the ~~plurality of checksum[[s]] outputs~~ based on a type of the Reed-Muller code;

an accumulator ~~configured~~ to accumulate the selected checksum[[s]] outputs;
and

a hard decision unit ~~configured~~ to hard-decide an output from the accumulator.

10. (Currently amended) A method of decoding a Reed-Muller code in which information data is encoded by using mask symbols and orthogonal codes, the information data including a first portion and a second portion, the method comprising:

calculating an exclusive OR of the Reed-Muller code and each of a plurality of mask patterns to obtain a first Reed-Muller code, each of the mask patterns

representing an exclusive ORed value of a candidate pattern of the mask symbols and the first portion of the information data corresponding to the candidate pattern;

calculating a checksum of the exclusive OR to obtain a plurality of checksum outputs; [[and]]

~~majority decide~~ deciding by majority a value of each of the checksums to decode a part of the second portion of the information data corresponding to the orthogonal codes;

calculating a first accumulation result of each bit bits of a product of decoded data and the orthogonal codes and a second accumulation result of [[each]] inverted bits of a product of the decoded data and the orthogonal codes; [[and]]

detecting one of the first accumulation result and the second accumulation result which corresponds to a smaller Euclidean distance between the ~~input~~ Reed-Muller code and encoded data of the decoded data;

detecting the minimum of one of the first accumulation result and the second accumulation result which has a smaller Euclidean distance between the ~~input~~ Reed-Muller code and encoded data of the decoded data while calculating the exclusive OR of the Reed-Muller code and an exclusive ORed value of each of a plurality of candidate the mask patterns of the mask symbols and the information data corresponding to the candidate pattern,

whereby decoding the first portion of the information data is decoded based on the mask symbols pattern corresponding to the minimum of one of the first accumulation result and the second accumulation result which has a smaller Euclidean distance between the ~~input~~ Reed-Muller code and encoded data of the decoded data.

11. (Currently amended) An apparatus for decoding a Reed-Muller code in which information data is encoded by using mask symbols and orthogonal codes, the information data including a first portion and a second portion, the apparatus comprising:

an arithmetic operation unit ~~configured~~ to calculate a first product of [[the]] a first Reed-Muller code and each of a plurality of mask patterns to obtain a first exclusive OR output, each of the mask patterns representing an exclusive ORed value of a candidate pattern of the mask symbols and the first portion of the information data corresponding to the candidate pattern;

a first decoder configured to decode a part of the second portion of the information data corresponding to the orthogonal codes calculate by calculating a checksum of the first product to obtain a plurality of checksum outputs and majority decide deciding by majority each of the checksum outputs to decode a part of the second portion of the information data corresponding to the orthogonal codes;

a second decoder configured to calculate to decode a remaining part of the second portion of the information data corresponding to the orthogonal codes by calculating a second product of the first product and a product of the part of the second portion of the information data and the orthogonal codes and majority decides deciding by majority the second product to decode a remaining part of the second portion of the information data corresponding to the orthogonal codes;

a Reed-Muller encoder configured to Reed-Muller encode the second portion of the information data output from the first decoder and the second decoder and the first portion of the information data into a Reed-Muller code;

a maximum correlation detector configured to detect the maximum of a correlation between an output from the first Reed-Muller encoder and the second Reed-Muller code supplied to the arithmetic operation unit while a plurality of candidate patterns of the mask symbols the mask patterns are supplied to the arithmetic operation unit[[,]];

whereby a decoder to decode the first portion of the information data is decoded based on the mask symbols pattern corresponding to the maximum of the correlation.

12. (Currently amended) The apparatus according to claim 11, further comprising a memory configured to store a plurality of exclusive ORed values of a plurality of candidate patterns of the mask symbols the mask patterns and a plurality of the information data corresponding to the candidate mask patterns, and wherein the arithmetic operation unit calculates the first product of the first Reed-Muller code and each of the plurality of exclusive ORed values stored in the memory.

13. (Currently amended) The apparatus according to claim 11, wherein the first decoder comprises:

a memory configured to store the first product;

a checksum calculator configured to read bit data from the memory and calculate a plurality of exclusive ORs of a plurality of sets of the read bit data to obtain [[a]] the plurality of checksum[[s]] outputs;

a selector configured to select some of the plurality of checksum[[s]] outputs based on a type of the Reed-Muller code; and

an accumulator configured to accumulate the selected checksum[[s]] outputs.

14. (Currently amended) A method of decoding Reed-Muller code in which information data is encoded by using mask symbols and orthogonal codes, the information data including a first portion and a second portion, the method comprising:

calculating a first product of the Reed-Muller code and each of a plurality of mask patterns, each of the mask patterns representing an exclusive ORed value of a candidate pattern of the mask symbols and the information data corresponding to the candidate pattern;

calculating a checksum of the first product to obtain a plurality of checksum outputs; and majority decide

deciding by majority a value of each of the checksum outputs to decode a part of the second portion of the information data corresponding to the orthogonal codes;

calculating a second product of the first product and a product of the part of the second portion of the information data and the orthogonal codes; and majority decides deciding by majority the second product to decode a remaining part of the second portion of the information data corresponding to the orthogonal codes;

Reed-Muller encoding the second portion of the information data and the first portion of the information data into a second Reed-Muller code; and
~~detecting the maximum of a correlation between the first Reed-Muller encoded-data code and an input the second Reed-Muller code while a plurality of first products are calculated, whereby the first portion of the information data is decoded based on the mask symbols pattern corresponding to the maximum of the correlation.~~

15. (Currently amended) An apparatus for decoding Reed-Muller code in which information data is encoded by using mask symbols and orthogonal codes, the information data including a first portion and a second portion, the apparatus comprising:

a first arithmetic operation unit ~~configured to calculate a first product of the Reed-Muller code and each of a plurality of mask patterns, each of the mask patterns representing an exclusive ORed value of a candidate pattern of the mask symbols and the information data corresponding to the candidate pattern;~~

~~a decoder configured to calculate to decode a part of the second portion of the information data corresponding to the orthogonal codes by calculating a checksum of the first product and majority-decide deciding by majority the checksum to decode a part of the second portion of the information data corresponding to the orthogonal codes;~~

a second arithmetic operation unit ~~configured to calculate a first accumulation result of each bit bits of a product of an output from the decoder and the orthogonal codes and a second accumulation result of [[each]] inverted bits of a product of the~~

output from the decoder and the orthogonal codes and detect a larger one of the first accumulation result and the second accumulation result;

a maximum detector ~~configured~~ to detect the maximum of an output from the second arithmetic operation unit while ~~a plurality of candidate patterns of the mask symbols~~ the mask patterns are supplied to the first arithmetic operation unit[[,]];

whereby a decoder to decode the first portion of the information data ~~is decoded~~ based on the mask ~~symbols pattern~~ corresponding to the maximum of the output from the second arithmetic operation unit.

16. (Currently amended) The apparatus according to claim 15, further comprising a memory ~~configured~~ to store a plurality of exclusive ORed values of ~~a plurality of candidate patterns of the mask symbols~~ the mask patterns and a plurality of the information data corresponding to the candidate mask patterns, and wherein the first arithmetic operation unit calculates the first product of the first Reed-Muller code and each of the plurality of exclusive ORed values stored in the memory.

17. (Currently amended) The apparatus according to claim 15, wherein the decoder comprises:

a memory ~~configured~~ to store the first product;
a checksum calculator ~~configured~~ to read bit data from the memory and calculate a plurality of exclusive ORs of a plurality of sets of the read bit data to obtain a plurality of checksums;

a selector configured to select some of the plurality of checksums based on a type of the Reed-Muller code; and

an accumulator configured to accumulate the selected checksums.

18. (Currently amended) A method of decoding Reed-Muller code in which information data is encoded by using mask symbols and orthogonal codes, the information data including a first portion and a second portion, the method comprising:

calculating a first product of the Reed-Muller code and each of a plurality of mask patterns, each of the mask patterns representing an exclusive ORed value of a candidate pattern of the mask symbols and the information data corresponding to the candidate pattern;

calculating a checksum of the first product; and majority decide deciding by majority the checksum to decode a part of the second portion of the information data corresponding to the orthogonal codes;

calculating a first accumulation result of each bit bits of a product of decoded data and the orthogonal codes and a second accumulation result of each inverted bits of a product of the decoded data and the orthogonal codes; and detect

detecting a larger one of the first accumulation result and the second accumulation result;

detecting the maximum of the first accumulation result and the second accumulation result while calculating the first product of the Reed-Muller code and an exclusive ORed value of each of a plurality of candidate the mask patterns of the mask symbols and the information data corresponding to the candidate pattern; and

whereby decoding the first portion of the information data is decoded based on the mask symbols pattern corresponding to the maximum of the first accumulation result and the second accumulation result.